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Emergence and Development of Industry Clusters in Hungary

Searching for a 'Critical Mass' of Business via Cluster Mapping

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Abstract: In the epoch of globalization, small or medium-sized national companies have great difficulties in finding an appropriate place for themselves in global labor division systems. They most frequently apply either strategies that help them becoming part of global value chains as regular suppliers, or they try to locate in which they might cooperate with other small companies in industrial clusters to compete with larger multinational companies. In both cases, communication, knowledge transfer, and cooperative actions among companies are essential for improving competitive capacities. Since this type of cooperation relies heavily on close, regular contact and face-to-face interaction, the spatial concentration of actors can improve the chances for success. Literature on the topic of supplier networks and spillover effects, as well as that on industrial clusters, emphasizes the importance of a "critical mass" of companies and other organizations and institutions. The authors first define and describe the types of synergies that stem from co-location of cooperating market actors. In addition the potential linkages among the two types of networks, supplier chains and clusters are explained. After a brief overview of the related literature, the authors introduce a new, refined measurement method of spatial concentration with empirical survey results from Hungary.

JEL classification numbers: D24, F23, L14, L16, P23, R12

Key words: industry cluster, supplier network, foreign direct investment, Hungary

1. Introduction

Industry clusters (ICs) have attracted much attention in the recent past. Besides the ever-growing academic interest, ICs have become primary targets of development policy. Various documents of the European Commission (EC) have expressed strong confidence in ICs as exceptionally suitable drivers of economic growth, innovation, and competitiveness (EC, 2003; 2008a; 2008b). National governments and EC-supported policies were designed to promote the process of clustering and the establishment of cluster organizations. Another important string of literature and policy practice is foreign direct investment (FDI) attraction and the development of local linkages (for example, supplier networks) of foreign investment enterprises (FIEs). Both structures, ICs and widespread supplier networks, have common features. Most importantly, both need a sufficient number of potential collaborators. Both can be developed most successfully in regions where economic activity is vivid and enterprising and cooperation has traditions. It is therefore of special interest to learn what should and could be the relationship between the two cooperation systems, what are their common features, and what are the differences?

Agglomeration of economic activity is a phenomenon that is as long as human history. Centers of active and vibrant economic development and welfare have attracted various businesses for centuries. As early as the work of Marshall (1890), there has been an awareness of the importance of geographical proximity in determining the location of industrial activity. Marshall argued that clusters develop as a consequence of three factors: (a) the presence of a skilled local labor market; (b) key inputs from suppliers; and (c) rapid know-how transfer between firms, leading to technological spillover. Hence, regional concentration is not a new phenomenon. What is then new in clusters?

The industrial clustering work by Michael Porter (1990; 1998; 2003) is regarded as seminal. He emphasized that firm competitiveness was determined by multiple factors only partly endogenous to them. In his "diamond model," four sets of interrelated forces are introduced to explain industrial dynamics and competitiveness. These are associated with factor input conditions, sophisticated local demand conditions, related and supported industries, and firm structure, strategy, and rivalry. A core notion arose around his model, stressing that a collaborative, mutually supportive group of actors could enhance regional competitiveness in global markets and, thus, create growth and other benefits. In addition, the significance of face-to-face contacts and personal demonstration, exchange of experience, and role of geographical proximity for knowledge transfers and innovation has been explored and emphasized. Another string

of related economic thought elaborated on knowledge creation and innovation as a social process engaging individuals that exchange tacit and explicit knowledge. Trust-based relationships and social capital may, thus, be important for enabling horizontal cooperation between individuals within and across firms and institutions (Pouder and St. John, 1996; Saxenian, 1994).

ICs are spatial concentrations of business and related institutions with activity specialization and active cooperation linkages among cluster members.[1] IC activity may be facilitated by cluster organizations (cluster initiatives). Nevertheless, the latter are institutions rather than an economic phenomenon, and we make a clear distinction between them. The essence of ICs is member cooperation, and the main benefits that they obtain stem from joint actions. FIEs may also benefit from cooperation with ICs related to their core activity. Nevertheless, the linkage is more often the opposite. Local companies and, more importantly, governments promote joint actions sometimes organized as ICs in order to facilitate cooperation with FIEs. One of the main FDI-related policy aims is to promote their embeddedness into local economic environments and loosen their island-like appearance in the host economy. Developing local linkages, however, requires actions from both sides of the FIEs and the local firms. Governments usually have greater influence on local small and medium-sized firms and can better facilitate their efforts to become suppliers of FIEs. An interesting new tool in this effort is cluster promotion and their potential role in facilitating FIE local supplier networks.[2]

For the study of cluster emergence and their further development, the Hungarian experience has potential to be taken as the best laboratory case in the context of transition economies. It is well-known that Hungary has been a leader among Central European states in terms of the total accumulated FDI inflows during the early 1990s. This vast influx of foreign capital formed a mega economic sector of FIEs within the country (Iwasaki, 2007). As discussed later, there is considerable room for the development of production networks between incoming multinational enterprises (MNEs) and local companies (Acs et al., 2007). Nevertheless, it is also true that the

[1] Michael Porter's original definition for clusters is as follows: "Clusters are geographic concentrations of interconnected companies, specialized suppliers and service providers, firms in related industries, and associated institutions (for example universities, standards agencies, and trade associations) in particular fields that compete but also co-operate" (Porter, 1990, p.199). The main aim of this cooperation is enhancing the competitiveness of regions and actors in the region.

[2] For more details on supplier network promotion programs in Hungary, see Sass and Szanyi (2004), ICEG (2006), and Sass et al. (2009).

business activity of FIEs has taken greater root in local communities and their alliance with indigenous companies, especially in manufacturing and service industries, has achieved larger scale and depth through parts supply and outsourcing than before. This recent progress is empirically supported by our studies, which confirmed the positive and statistically significant FDI spillover effects on the productivity and export propensity of domestic firms for the early 2000s (Iwasaki et al., 2009; 2010). As a result, newly emerged clusters of FDI-led businesses can now be observed in many regions, which gives us the opportunity to examine the determinants of cluster development and its possible impact on the national and regional economy in Hungary.

We can approach ICs on different levels. Since the co-location of business in close geographical proximity is an organic development, we can focus on a real economic clustering process, i.e., how spatial concentrations of certain activities evolve or show up at a given time of observation. This is important, since benefits of close cooperation among firms are expected to arise when cooperating agents exceed a certain number, the "critical mass."[3] We can make observations using statistical analysis of activities on the local level. First, such an extensive "cluster mapping" exercise was carried out in the US by Michael Porter's team at Harvard Business School. Since then, several similar calculations were made using Porter's original method. In this paper, we review previous mapping exercises and report our own results for Hungary.

The remainder of this paper is organized as follows: In Section 2, we briefly summarize the existing literature on the relationship of supplier networks and cluster development in Hungary. Section 3 deals with measuring the regional density of economic activity using Michael Porter's measurement idea, the cluster mapping methodology. In this section, we introduce the results of previous mapping exercises as well as our own research results, which were based on a modified measurement method that expanded the number of measures and refined the database in geographic terms. In Section 4, we perform cluster mapping using the census-type data of Hungarian firms. The concluding remarks follow.

[3] One main precondition of a successful cluster operation is the presence of a fairly large and diverse pool of economic agents specializing in similar or supportive activities. The sufficiently large specialized local economic activity is crucial for knowledge generation and transfer, for the internal stability of cluster organizations, for the visibility of clusters, and for the self-sustaining development of cluster activities. For more general descriptions and various interpretations of the cluster concept, see Porter (1998), Sölvell et al. (2003), ICEG (2007), Sölvell (2008), EC (2008b), and Szanyi (2008b).

2. Supplier networks and cluster development in Hungary

ICs are flexible production platforms with some kind of activity specialization. Cluster operation can be targeted directly to consumer markets but also to supplies of specific intermediate products. In some cases, ICs are organized as an alliance of equal parties (i.e., firms with similar size and importance). In other cases, an organization is more satellite-like, and there is one or a few large companies that determine cluster activities according to their input demands. In this latter case, cluster participants and activities are organized in order to enhance the competitiveness of the whole value chain, on top of which there usually are western large-scale MNEs. It is important to emphasize that FIE-centered ICs may work properly only on the basis of mutual benefits. Cluster cooperation, which is largely sponsored by the FIE, must bring benefits for suppliers in terms of technological up-grading, market access, and sometimes even financial support. The benefits of FIEs may range from access to less expensive and flexible local supplies to a better labor force pool and technology assistance.

The essence of ICs is the mutually beneficial co-operation of various economic actors. Hence, true ICs expand beyond the mere FIE supplier networks. They include non-business participants, and their activity goes beyond the technical organization of supplies. Most common is the technology and knowledge transfer to facilitate the technical and managerial capabilities of small suppliers. There is also financial support to undertake necessary investments. However, in this type of cooperation, there is relatively little emphasis on innovation and technological cooperation, at least for the time being.

FIEs may also be important players in the innovation process of ICs. They were always regarded as primary sources of technology to the host transition economy. Whenever their local involvement increases, interfaces of technological spillovers also widen. Hence, ICs may serve as good platforms of knowledge transfer between FIEs and local actors. The concept of dynamic clusters[4] emphasizes innovative cooperation among partners rather than one-way transfers of knowledge. It is not self-evident that FIE

[4] Sölvell et al. (2003) ran the first major questionnaire-based empirical survey on cluster organizations worldwide. Using the survey results, they described a typical or best-practice cluster type: the most common appearance of clusters. Because of the overrepresentation of clusters from developed market economies, this model, which they called a dynamic cluster, basically reflected those characteristics, cooperation forms, and structures that were found to be typical in more developed economies. Later research, including Ketels and Sölvell (2005) and Ketels et al. (2006), revealed the fact that, in emerging market economies or developing countries, clusters may substantially differ concerning their focus of activity and working models.

strategies exceed the technical minimum of knowledge transfer towards suppliers. Their links to local universities or research laboratories also depend on many factors that are independent from cluster policies (Sass and Szanyi, 2004).

MNEs are desired participants of ICs (Sölvell et al., 2003). They may support cluster development in several ways. They are in direct contact with world markets and can potentially bring breaking news to the cluster first-hand. Through their widespread international linkages, these companies may support international activities of the cluster and smaller cluster members. They may even lobby for their partners' interests. Another potential support area is technology. MNEs usually have cutting-edge technology and are able to provide technology and knowledge transfer to strategic partners. In the case of stable supplier contacts, technology transfer and support to enable small firms to become suppliers are rather usual. The intensity of such linkage very much depends on the level of MNEs' inclination for supplier network development with nationality, global strategy as perhaps the strongest determinants of this inclination. Another technology-related area is R&D. One of the essential cluster functions, especially in the case of dynamic clusters, is knowledge generation and distribution within the ICs. Should there be intensive R&D linkages within the cluster members, including research institutions and universities, it is likely that also MNEs will participate in this collaboration. Related to knowledge generation is training and education. This is also based on cooperation of heterogeneous partners, also including MNEs.

We believe that, at least for the time being, emerging market economies do not offer strong conditions for knowledge-based dynamic clusters or innovation systems that could provide strategic innovation inputs for MNEs, though many of them possess strong innovation communities that could potentially serve as a knowledge-generating network with international importance. Thus, it is highly likely that the interest of MNEs in developing deep cooperation networks with cluster participation is weaker in emerging market economies, including Hungary, than in developed countries. Nevertheless, similarly to conditions for developing supplier networks, cluster participation is plausible and desirable, although the likelihood and modes of participation may greatly vary. In the next section, we compare the conditions of supplier network development with those of cluster establishment from the angle of MNEs. This comparison will also highlight possible ways of organizing ICs based on existing supplier networks of MNEs.

In general, we expect that factors increasing the likelihood of supplier network development also increase the propensity for cluster involvement. However, the two

phenomena are not identical, and, in some cases, interests may differ substantially. Therefore, it is necessary to consider these determinants from a cluster viewpoint. These are: spatial concentration, specialization, heterogeneity of actors, simultaneous competition and cooperation, critical mass, and typical cluster activities.

As far as the geographic concentration is concerned, we can immediately realize that, in Hungary, the main areas for FDI are identical with those of intensive cluster development. It is mainly the capital city and the Central and Western Transdanubia regions, where both clusters and FDIs accumulate.[5] In fact, investments started to settle in important agglomerations already in the 1990s, while cluster development (meaning formal cluster initiatives) started only after 2000. Causal relations are rather unclear, hence these regions used to be rather developed industrial centers prior to the transition period, and their production potentials significantly contributed to FDI attraction. Later, this attraction potential was further strengthened by the MNEs themselves. Leading original equipment manufacturers (OEMs) attracted their traditional suppliers to invest in the same region in order to ensure easy and smooth cooperation. This FDI pattern itself contributed to a large extent to the creation of sufficient pools of specialized firms within close vicinity. OEMs also exercised a strong pulling effect on local suppliers. While many of them had their premises in these historic industrial districts, new firms also settled in them. This process was strengthened by some policy measures as well. For over a decade or so, special industrial zones enjoyed privileges in the form of tax and customs relief provided that they exported their output in its entirety. Tax-free zones became hubs for greenfield investments that also incorporated many Hungarian suppliers (Antalóczy and Sass, 2001; Sass, 2003).

Much of the export-oriented greenfield investment was carried out in the tax-free zones; however, it is also worth noting that some 100 such zones were created in Hungary, since regulations for the establishment were rather easy to meet. Therefore, the likely pattern of spatial concentration was one OEM and its traditional first tire suppliers, completed by local second and third tire supplier companies. Only on rare occasions did OEMs with similar final product settle in the same hub. They separated themselves from their competitors and seemed to prefer separating their supplier network as well (Szalavetz, 2001).

Consequently, significant concentrations of specialized firms were created in Hungary's more developed areas. These networks consisted of technologically dependent

[5] For maps of NUTS-2 and NUTS-3 administrative geographical units, see the Appendix at the end of the chapter.

suppliers of the value chain of single OEMs. The types of cooperation also contributed to the smooth functioning of the chain. Technology and knowledge transfer were provided by the OEMs and other major firms to Hungarian smaller suppliers in the areas to the extent it was necessary to improve their supply capabilities. This knowledge transfer and, generally speaking, all cooperation links were vertical: the OEM was in the center, and other firms depended on them as satellites. Not only did OEMs avoid contacting other OEMs of their branch, but the horizontal linkages of suppliers were also curtailed (or at least not promoted), i.e., both contacts to other MNEs and linkages among suppliers (for example, in the case of Electrolux).[6] There is some evidence that MNEs liked sporadic suppliers also because they could bargain for lower prices when handling with separated, individual companies (Szanyi, 2008a). Summing up, FDI created hot spots for potential cluster development, but MNEs were not really interested in creating cooperation and communication platforms among supplier firms, which would be an essential cluster function.

We must emphasize the role of the tax-free zones in the spatial development of industrial districts in the first phase of the transition period. The advantageous regulation was, however, lifted while Hungary was joining the European Union (EU), since it was not regarded as compatible with competition rules. In addition, in this period, there was another pattern of FDI in Hungary, which was more connected with the privatization process and was regarded as more likely leading to the development of supplier networks. From the point of view of the development of horizontal linkages, and the possibility of becoming suppliers of several firms, (various OEMs) there is anecdotal evidence proving that cooperation linkages were more frequent in this second FDI pattern. However, MNEs were in many of the privatization cases not more interested in the further development of horizontal linkages among suppliers. Nevertheless, traditional cooperation among some of the local based suppliers might remain intact. Hence, the development of local cooperation linkages around these OEMs can be more likely than in the case of greenfield investments.

Another aspect of cluster development is the heterogeneity of members. It is rather clear that supplier networks around MNEs serve primarily the business interests of the integrating company. Anything beyond this interest must be initiated by other parties. The day-to-day interest of MNEs is simple: they must run their production facilities smoothly and efficiently since many of them are efficiency seeking. They need reliable

[6] For more details, see ICEG (2006).

business partners in the value chain. However, basically, and especially in the early years of their investments, they do not care much about the broader background. Many MNEs regard investment projects as one-off deals that last until favorable conditions prevail, but they do not intend to get involved in supporting the longer-term provision of the conditions. Therefore, institutions of the broader production background (education, infrastructure, and local development) remain outside of their attention. As a result of this, the early-phase local production networks usually lack diversity, which would be an important feature of ICs.

This situation is changing with the age and development of investment projects. There is much empirical evidence that shows how even greenfield investments changed their nature and behavior (Szalavetz, 2005; Szanyi, 2003; Hunya, 2001). This is because it is in their own efficiency-seeking interest to tap cheap opportunities throughout the whole value chain. Therefore, they expand their activity from the final assembly of imported parts to increasing the local component supply to increasing local participation in corporate functions (from accounting through logistics and even to R&D). This expansion of affiliate activity in global corporate networks is in line with the current wave of concentrating on core competences and outsourcing/off shoring much of the activities (Sass, 2008). The higher the number of activities that are carried out locally, the more likely business and cooperation links are developed in various directions, exceeding the simple technological cooperation of suppliers. Whenever there is more room for contacts among heterogeneous market actors, the potential also increases for organizing these contacts and actors in some formal ways. The clustering process may also get started from the bottom.

Recent experiences with labor shortage in some industrial bases in Hungary opened up new frontiers of cooperation with MNEs. National Instruments in Debrecen, Siemens in Budapest, Nokia in Szeged, and Audi in Győr are just a few examples of MNEs participating in shaping and also financing education programs of universities. Of course, they do this because they need high quality labor supply also in the future. Another welcome development pattern is the increasing participation of MNEs in financing and participation in R&D projects in Hungary. Some of the leading investors in Hungary established R&D laboratories in the country. This also substantially increased the clustering potentials of some cities in which sufficient educational and innovation background was present. We do not believe that dynamic clusters will soon play an important role in Hungary's economic development. It will be good if MNEs at least realize that they may also benefit from cluster cooperation in Hungary and become

active members of ICs. Nevertheless, the mere fact that universities, R&D facilities, maybe also other actors raised their interest in cooperation also supports the cluster idea and increases chances for proper cluster actions.

Concerning the coexistence of cooperation and competition, Hungarian ICs may play a positive role. MNE supplier networks always supported intensive competition among local firms. The degree of cooperation was insufficient; however, it was clearly demonstrated that local firms benefitted when they improved their abilities in joint actions rather than individually. ICs may play an important role in organizing various programs for the development of participating SMEs. This is also in the interest of the MNEs heading the value chain. Other forms of cooperation, most importantly, technology and knowledge transfer, possibly even generation, are also plausible in supplier-based ICs, especially if cluster members can change their way of thinking regarding vertical flows but recognize that there is also room for joint horizontal actions. The empirical evidence indicates that this is the most difficult task for cluster managers since many of the potential cluster members are competitors and compete for contracts of the top OEMs or first tire foreign suppliers. Promoting MNE interest in cluster cooperation is sometimes not any more difficult than building trust among competing local suppliers.

As far as the critical mass of ICs is concerned, there is very little information on this issue in Hungary. Empirical surveys have indicated that formal cluster organizations do not set such targets (Szanyi, 2008a). Many are in their early stage of development; thus, the question is not yet relevant for them. Nevertheless, we can draw some general conclusions using guidelines available in the literature (Sölvell, 2003; ECOTEC, 2003; CLOE, 2006). Achieving a critical mass is important for three reasons. One is stability, which protecting against potential dropouts of large, dominating firms; the second is a financially self-sustaining cluster and new entry attraction; and the third is achieving a critical mass of information flow and activity, which is a kind of density of cluster actions that provides the desired synergies. MNE supplier networks alone have little opportunity to achieve these goals. The membership of competing OEMs is not likely. However, there may be ICs that are not initiated and dominated by OEMs but are established by other parties, building on suppliers to MNEs. In this case, the initial favorable condition of the supplier network is utilized; namely, there is a pool of potential cluster members. Drawing on this pool, a cluster can be organized with or without the participation of the MNE itself. The case of the oldest and largest Hungarian cluster, the Pannon Automotive Cluster (PANAC), is a good example of this.

However, even this cluster could not develop activities away from a simple supplier network support for many years. It took time and a setback in the cluster activity until cluster management realized that proper cluster functioning cannot be solely based on supplier network development programs (Grosz, 2006). Representing the cluster's own interests as a separate organization is crucial and cannot be subordinated to one company's business interests. In addition, professional cluster management needs to be employed as well so that regular cluster functions are developed.

As reported above, there is little information available on the actual concentration of economic activity or the achievement of critical mass in Hungary. In the remaining part of this paper, we try to fill the information gap concerning existing critical mass of firms and economic activity in Hungary using large-scale firm-level data. Before doing this, we briefly review the results of some other cluster-mapping studies for comparison.

3. Cluster-mapping practices

While the origins of clustering included mostly bottom-up organizations, increased interest in cluster development as a policy tool resulted in large numbers of ICs that did not have traditional or organic spatial development roots. Many times, it was governments that boosted the organization of cluster initiatives. If countries wish to launch a thoroughly designed program, information has to be gathered and evaluated first. For the purpose of the promotion of the clustering process or the foundation of cluster organizations, it is necessary to check if conditions for clustering are given or not. Two characteristics are crucial. The first is spatial concentration, and the second is specialization on some core competence. It is obvious that, in the case of a top-down initiative, these characteristics can be controlled in advance. It is surprising that cluster mapping has not become a general practice by governments other than that of the USA, where a nationwide effort was made in the late 1990s. Some countries also calculated spatial concentration measures, but not even these efforts were always given the right attention by policy makers. For example, in Hungary, there was such an effort in 2003, but it was conducted when the cluster promotion program had already been opened for application (Ravn and Petersen, 2005). An *ex-post* survey compared the identified ICs with the list of existing cluster initiatives. Only 10 of the then 22 Hungarian cluster initiatives matched the hot-spot map that identified 24 examples of above-average spatial concentration of industries (Gecse, 2004).

The above-mentioned weak result of match by actual cluster initiatives and statistically registered spatial concentrations raises the question of how to explain this failure. The question is whether it was the inappropriate analytical framework that created distortions in the mapping procedure or rather, it was due to a high number of "virtual cluster initiatives"? However, most likely, both explanations are accurate.

A brief overview of methodological problems is presented in the following section. The cluster-mapping procedure tries to identify spatial locations where the representation of certain industries or economic activities is higher than average, i.e., where they seem to concentrate. The logic is simple. In these places, there must be some kind of competitive advantage that is perceived by economic actors, and they tend to co-locate. There are three types of industries that have different reasons to co-locate. A large number of manufacturing branches as well as service providers, typically personal services, are located right at their markets. The dispersion of such industries is roughly even in all regions. Per capita measures, for example, are very close to each other in the various geographic regions of a country. Natural resource-based industries, on the other hand, tend to concentrate mainly at the location of the valuable asset. These industries may serve the global market, but they do not have much locational choice. The third group of activities is the most important one. These are industries that concentrate at locations; hence, they choose among many potential sites. These industries are regarded as cluster industries. In the case of the US economy, their proportional share in employment was close to one third, but they recorded higher than average wages, productivity, and innovation (Ketels and Sölvell, 2005).

Ketels and Sölvell (2005) ran a comprehensive statistical survey of cluster mapping in the 10 new member states of the EU, including Hungary (EU-10). Their methodology was based on the methods of a survey that was conducted at the Institute for Strategy and Competitiveness at Harvard Business School led by Michael Porter.[7] The European survey used the amended American industrial classification method when identifying those business activities that belonged to cluster industries. Spatial concentration was calculated for the European NUTS-2-level regions. Only employment data was readily available at this level of both sectoral and geographic disaggregation (38 businesses) and for two comparatively recent years (2000 and 2004). Thus, concentration was measured with this single data set. However, the authors calculated three different measures in order to limit some of the distortions stemming from the special features of employment

[7] See the Website of the cluster mapping project of the Institute for Strategy and Competitiveness (http://data.isc.hbs.edu/isc/index.jsp).

data. They wanted to obtain a balanced picture of regions reaching sufficient specialized critical mass to develop the type of spillovers and linkages that create positive economic effects that can serve as a base for cluster initiatives.

The first measure expressed the size, whether employment reached a sufficient absolute level that has the potential to trigger strong economic effects of ICs. This level was set for each NUTS-2 region and every of the 38 branch with 15,000 employees at a location. The second measure expressed specialization, meaning that a region is more specialized in a specific cluster category than the overall economy across all regions, and therefore it may provide enough strength for the regional cluster to attract related economic activity from other regions. This notion was operationalized by regarding as fit those concentrations that reached a specialization quotient of more than 1.75, i.e., those which had at least 75 % more employment within the given cluster than the average of all regions would suggest given their size. The third measure expressed dominance, whether branches employ a high share of the given region's overall labor. The measure was set at the level of 7 % of overall regional employment. The level of all three measures was set to separate the highest 10 percentile of all regional ICs.

As expressed by the authors, the measurement method had several shortcomings. The first is the exclusive use of employment figures, which created a bias towards labor-intensive sectors. Another problem is the level of disaggregation in both dimensions. The 38 activity groups or businesses contain many that are rather heterogeneous. A deeper level of disaggregation was not possible, since the original grouping pattern, which was based on more detailed surveys of the US economy, could be transformed from the American SIC classification structure to European NACE only at this level.

With regard to the NUTS-2 regions, they are also too big in at least some countries and for some activities. In Hungary, for example, NUTS-2 regions were artificially created as requested by the EU, but they consist of usually 3 former *comitats* that, historically, used to be the integrating geographic and administrative unit. The new NUTS-2 regions are so young that their economies could hardly amalgamate. On the other hand, there is no convincing evidence on ICs spreading according to administrative borders either. Thus, some ICs may have escaped mapping because they spread over two or even more NUTS-2 regions.

A further problem comes from the inheritance of previous industrial structures. In most socialist countries, production was heavily concentrated in large state-owned companies. In some cases, these huge *combinates* were located in places of arbitrary choice; in other cases, firms were created by the governments of these countries in their

strive for self-supply in practically all commodities even if production inputs were not readily available. In many cases, these giants or their remnants survived the turmoil of the transition process. In other cases the least mobile production factor labor remained in places where it had accumulated during the years of socialist industrialization. All this experience seriously distorted spatial concentration patterns from the hypothetical optimum, and the old patterns still exercise influence on spatial differences in the supply of production factors. Thus, we may have strong reservations as far as the applicability of the results of current cluster mapping is concerned.

Ketels and Sölvell's survey found, nevertheless, interesting results: First, 367 regional ICs met at least one of the three hurdle rates for absolute size, specialization, and dominance. They represented 5,86 mn employees, which is about 58 % of total employment in the cluster sector of the 10 new member states. Second, the capital regions of the largest countries led the ranking of regions by cluster portfolio strength: Budapest first, Warsaw second, and Prague fourth. Third, the largest seven cluster categories were food processing, heavy construction services, transportation and logistics, financial services, hospitality and tourism, metal forming, and building fixtures, equipment and services, all of which accounted for 50 % of all cluster sector employment across the EU 10. As is evident, these are mainly labor intensive branches with a relatively lower level of productivity which provides a clear indication for sample bias. For example, automotive and ICT employed far fewer individuals, however they used to be considered as leading sectors for many ICs).

The research confirmed existing hypotheses concerning the development gap between developed countries and transition member states in the EU. The 10 EU economies had a specialization profile distinct from the more advanced economies. Specialization was found to have a far stronger natural resource-driven sector (20 % share in employment) than developed countries. Within the cluster sector (32 % share in employment), there was a stronger bias towards labor-intensive and manufacturing-driven cluster categories, while these countries had relatively few ICs in advanced services and knowledge-intensive cluster categories. Exceptions were the strongest clustering centers around capital cities. In addition, in the case of the Hungarian ICs, the bias reported above was less pronounced, and specialization towards high-value-added services and industries was stronger (see **Table 1**).

There may be several factors affecting the results of the above table that seems to underestimate IC potential in the region. For example, no Slovenian cluster qualified for all three dimensions. Ketels and Sölvell (2005) found convincing evidence on the

correlation of spatial concentration and economic performance using the data of developed countries. However, the spatial concentration had different historic reasons in practically all of the 10 new EU countries, and these traditions seem to have a much weaker causal link to economic growth and performance today. For example, in the case of the strong position of the Kosice region in the Slovak Republic, we must not forget that this is one of the poorest regions of the EU 25. The Kosice steel mill and very few other industrial facilities are the single most important employer of a region where unemployment rates are extraordinarily high. Thus, we may observe cases in which spatial concentration of business is the result of an overall meltdown of business activity in some regions and not the beneficial outcome of a deliberate co-location decision of independent cluster actors.

It is perhaps more useful to look at the overall clustering performance of regional centers. **Table 2** contains a list of regional centers that attracted the largest cluster portfolio, i.e., businesses that qualified in one or more aspects of cluster measures.

There are large differences within the EU-10 across regions and cluster categories regarding their level of specialization and spatial concentration. These countries show much lower specialization on specific regional ICs within regions and much lower spatial concentration on specific regions within cluster categories than the original benchmark US economy. If, as is suggested by the authors, higher levels of specialization and concentration enable higher productivity and innovation, this is a serious concern. The same concern arises with regard to the EU-15 countries in comparison with the US, which is fully consistent with the performance gap relative to the United States.

The EU implemented Porter's idea as extended by Sölvell and addressed dynamic clusters, or "innovative clusters," as they are referred to by the EC, which serves as a cornerstone of the more concrete and operative implementation plan targeted by Lisbon in the mid-2000s. The emphasis on cluster development in Europe provides new impetus for cluster research. Based on previous work at the Stockholm School of Economics, new research institutions were created. The European Cluster Observatory started to work in 2005. One main research output of this institution is its cluster mapping database.[8] The database contains employment data broken down according to Porter's original categorization of traded clusters for the European NUTS-2-level regions. Similar measures as those used by Ketels and and Sölvell (2005) were calculated. Thus, the problem of using only one indicator (employment), as well as the broad and

[8] See the European Cluster Observatory special Website (http://www.clusterobservatory.eu).

rather rigid separation of regions remains in this database. Nevertheless, the availability of methodologically comparable data for the whole territory of the EU is an important new feature in cluster research. In addition, the database contains some basic evaluation of the registered cluster exports and innovative activities that helps readers identify the true innovative clusters.

As far as the actual results are concerned, data of the observed Hungarian ICs are summarized in **Table 3**. As is seen, none of the spatial concentrations in Hungary qualified in all three measurement aspects in 2007 (in 2004, there were three). The number of two-star ICs also declined. Some of the 2004 two-star ICs lost one star, but, in two cases, i.e., building fixtures and business services in Central Hungary, the 2004 clusters were not reported in the 2007 table. On the other hand, 6 "new" two-star ICs appear in the 2007 table. They are certainly not new in the sense that these spatial concentrations have been known since they used to have a solid and traditional background and qualified for a one-to-two-star level.

Looking at the 2007 list of Hungarian ICs, the still strong positions of traditional sectors are evident. This is despite the less favorable development tendencies in the 1990s and 2000s. Strong path dependency is observed here. Despite the massive foreign investments in some global industries, such as automotive, electronics, and communication technology, important features of the Hungarian economy prevailed in the food industry, construction, and light industry, which retained important positions despite heavy contractions in the last 15 years.

Another important piece of information to be gleaned from the table is that innovation was found to be the strongest mainly in sectors that did not export much and did not belong to traditional high-technology activities. The loose relationship of high technology, innovation, and exports calls for caution when designing cluster-promotion tools aiming at export-oriented innovative clusters, which are at the heart of the current Hungarian and, to some extent, the European innovation policy (see for example EC (2008a; 2008b) and European Cluster Observatory (2007)). Porter stressed the importance of innovation in cluster activity, but he never reported that ICs were reserved for high-technology activities or for export-oriented industries. The heart of his concept is joint action for increasing regional competitiveness in general. One tool of this effort is the support of innovative cooperation in a wide range of industries and activities. Equally important in the cluster concept is its foundation on traditional regional sources and areas of competitiveness. These should be promoted by cluster cooperation. ICs should not be regarded as a means of capitalist industrialization.

As a conclusion, we can suggest further research in mapping spatial concentrations of business activity in the "traded cluster" sectors. It seems to be necessary to use alternative indicators, such as sales turnover, investments, or paid salaries, rather than the number of employees. In addition, the strict administrative boundaries of NUTS-2 regions should be made more flexibly to allow for the observation of "cross-border" clusters, or tighter spatial concentrations that "disappear" from calculations when comparing them with aggregated figures of larger areas. Such refinements in methodology will enhance a more reliable comparison of functioning cluster organizations and their background. This, in turn, would also contribute to a better formulation of cluster policies.

4. A new Hungarian cluster mapping

In this section, we perform a new cluster mapping exercise based on annual census-type data of Hungarian firms. The data were compiled from financial statements associated with tax reporting submitted to the National Tax Authority in Hungary by legal entities performing accounting and tax procedures by double-entry bookkeeping. The data contain basic information for each sample firm, including its geographical location, the NACE 4-digit codes, annual average number of employees, total turnovers, and other financial indices. First, we describe our empirical methodology followed by the results.

4.1. Methodology

We employ the 1998 and 2005 datasets to conduct mapping of ICs in Hungary using Porter's measurement method, which was described in the previous section. When transforming the industry categories of the database to the one that was defined in the HBS cluster mapping project, we could separate 37 out of the original 38 traded cluster activities.[9] Out of the three measures that were used by Ketels and Sölvell (2005), we used only one, namely, the specialization quotient. The design of the locational quotient is similar to Bela Balassa's RCA measure (revealed comparative advantage). It expresses the relative weight of one single sector in a region to the total weight of the region compared to either the national economy or a larger geographical area. The calculation is conducted using the following formula:

[9] For a thorough description of the traded cluster category, see the Website of the Cluster-mapping Project at: http://data.isc.hbs.edu/isc/index.jsp.

$$LQ_{ij} = \frac{e_{ij} / E_i}{e_j / E} = \frac{s_{ij}}{x_j}, \quad (1)$$

where e_{ij} is the number of employees in area *j* in branch *i*, e_j is the total number of employees in area *j*, E_i is the number of employees in branch *i* in the whole country (spatial unit of comparison), and E the is total number of employees in the whole country (spatial unit of comparison). Hence, s_{ij} denotes the share of area *j* in total employment of branch *i*, and x_j denotes the share of area *j* in total employment.

We found that the statistical content of the other two measures was quite similar. We also found the other two measures to be strongly biased by the absolute differences between firms, branches, and spatial units. Relative concentration is at the heart of the clustering process, and this requires relative measures. Comparisons that are based on the use of absolute values are, therefore, less applicable, since they reflect size biases.

Our calculations are new and more precise in two aspects. We could disaggregate our database in spatial terms from NUTS-2 level (regions) to NUTS-3 level (comitats).[10] This is important because, on a regional level, important concentrations can be neglected due to differences in terms of varying significance levels of the different economic activities. However, a finer spatial focus also allows for the observation of activity concentrations that do not follow the artificial boundaries of the regions. The other novelty of our calculation method was the usage of various measures of economic activity, not just employment data. We used employment (number of employed persons), number of enterprises, value added, and cumulated investment data (investments of the 1998-2005 period). Thus, the final product of the calculations was four measures for each traded cluster branch in each NUTS-3-level spatial unit for the year 2005 and three for the year 1998, since, for the starting year, no cumulated investment figure was available.

4.2. Results

The total number of calculation results was 740 (20 spatial units, 37 branches) for each of the four measures. For an easier overview and better analysis, we followed the evaluation method found in Ketels and Sölvell (2005). We gave one point for all branch-comitat pairs that belonged, in terms of the given measure, to the upper 15 % of the calculation values. Thus, every branch-comitat pair could receive a maximum of 4 points (3 points in 1998).[11] We considered those pairs in which at least two measures proved to

[10] The database allowed even deeper NUTS-4-level calculations.

[11] We also evaluated the branch-comitat pairs at a lower 30 % level.

be significant (they belonged to the highest 15 % and, therefore, received two points). We also calculated the Gini coefficients. This measure helps us determine whether activity concentration is caused by one or a few large companies or a number of medium-sized or several small firms. This is a very important aspect, since we want to measure the pool of potential co-operators, and, therefore, the actual size structure is highly relevant for us. The Gini-coefficient was calculated from employment figures. Values over 0.9 reflect a very uneven structure. If the number of firms (observations) is high (100 or more), then values as high as 0.7-0.8 already indicate that a number of medium-sized firms should also be present. Thus, cooperative structures, such as clusters or supplier networks, would have a sufficiently broad pool to serve as a base.

We could spot significant concentration in 22 of the 37 traded cluster branches for the year 2005. In the remaining 15 traded cluster branches, no branch-comitat pairs received at least two points. The results are summarized in **Table 4**. It is noteworthy that no services-centered cluster was captured by our calculations, although there is much anecdotal evidence on the existence of even formal cluster organizations based on various service activities (financial services, education, and entertainment). Of course, it is possible that this failure is related to the shortcomings of the measurement method. However, the absolute lack of indication in the whole country may also mean that either these ICs operate in an inappropriate environment (too few related companies) or may be very young organizations that are not yet measurable statistically. In case of the capital city, Budapest, a further option is also likely. This city is simply too big and has business activity that is too heterogeneous and does not allow statistically outstanding concentrations. The overall size limits the relative importance of sectors that would produce sufficiently large size in many aspects but whose large denominator permits them to go unnoticed. Due to this measurement problem, Budapest and Pest County did not show significant concentrations at all. Since, however, we could also provide the total number of firms in the given branch, high values of this data may still deliver the necessary information on spatial concentration.

As is seen in **Table 4** and also on the amended maps shown as **Figure 1**, in many cases, we included several comitats together to form a potential cluster. This idea stems from the logic that the spatial dispersion of clusters should not necessarily follow administrative boundaries. The lower spatial observation level (i.e., NUTS-3) allows us to better localize the potential spread of ICs in neighboring comitats. We treated the comitat-branch pair, which showed a significant concentration on the 15 % level as gravity centers, and added the neighboring comitats, which showed concentration on a

level of at least 33 %. In some branches, we could identify 2 and, in some cases, even 3 centers, the nucleus of potential cluster formations.[12] Such examples are presented on the amended cluster maps. The last two columns of the table provide an evaluation of the branch-comitat pairs concerning the likelihood that they may become real ICs. Our objections were placed in the last column, and they included wide spatial dispersion and a shortage of companies."?

Fifteen concentrations are found to be strong enough to form ICs. In many cases, cluster organizations already work in these centers. In 14 other cases, we inserted a question mark, indicating that either a strong concentration was not supported by a sufficiently high number of potential cooperating firms or the relatively strong comitats were not in each other's immediate neighborhood. That would have limited the frequent personal contacts of cluster members, which would also be an important aspect of successful cluster operations. In a few cases, we found that the original traded cluster categorization is not perfectly suitable for the Hungarian economy. For example, in the case of the branch agricultural products, Porter's original category included all types of farm products, such as crops and animal products. It also included equipment repair and other services. This is highly relevant for large and complex American farms, but it does not really apply to much smaller, more specialized Hungarian producers. In this case, another category could have reflected more precisely those activities along which Hungarian agricultural producers could potentially cooperate.

5. Concluding remarks

From a summary of the lessons of our cluster-mapping exercise for Hungary, we draw some important conclusions. It is necessary to show that most spatial concentrations (potential clusters) are located in areas where similar industrial activity had been carried out before the transition. This means that, despite the tremendous structural changes of the two decades of transition, some basic characteristics of spatial and activity structure of the Hungarian economy remained in place. This is important evidence that supports an important aspect of the IC-related literature, namely, that there is strong path-dependency in economic development. Path dependency also means, however, that

[12] It is noteworthy that spatial concentration is just one important condition of cluster formation. Hence, even if we call the observed concentrations clusters or potential clusters, it does by no means mean that there is an actual cluster organization present. HBS documents, as well as the European Cluster Observatory, also use the term "cluster" for spatial activity concentrations.

cluster policies can and should not be treated as a means of a new capitalist industrialization. The main aim of clustering is to further develop traditional regional strength in order to gain regional competitiveness. We do not want to deny the possibility of creating new structures in the long run. Indeed, in the case of the automotive industry and ICT production, development in Hungary by far exceeded previous levels. In these cases, the existing capacities and expertise played a relatively small role. However, such examples seem to be more the exception than the rule.

Another noteworthy result of the survey follows from the previous argument. We found ample evidence of the existence of activity concentrations in branches and regions that have strong FIE influence, such as the automotive and ICT sectors. There is much empirical evidence that shows the impact of important supplier networks. [13] Strengthening the clustering process in such vertically integrated networks would require the support for horizontal linkages among cluster members. However, we also found branches in which FIE involvement was much weaker. We can conclude, therefore, that cluster development in such regions and branches in which there is no FIE dominance is also possible. However, the structure and functions of these clusters may be very different. They have stronger horizontal and less vertical cooperation. In addition, the power relations are different in them.[14] In this second type of clusters, the main activity is rather small-business and regional development. This variation of cluster types calls for more refined and not uniform solutions in cluster development policy.

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[13] For the car industry and the role of PANAC, the Hungarian automotive cluster, see Grosz (2006).

[14] For evidence and case studies, see Szanyi (2008).

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Table 1. Strong regional clusters and their specialization in six Central and Eastern European Countries, 2004

Region	Field of specialization
Czech Republic	
Liberec	Automotive
Liberec	Textiles
Ostrava	Metal manufacturing
Praha city	Education and knowledge generation
Praha city	Entertainment
Praha city	Financial services
Praha region	Automotive
Hungary	
Győr	Automotive
Szeged	Food processing
Székesfehérvár	Information technology
Lithuania	Apparel
Latvia	Entertainment
Poland	
Gdansk	Transportation and logistics
Katowice	Automotive
Lodz	Apparel
Warszawa	Financial services
Wroclaw	Automotive
Slovakia	
Bratislava	Financial services
Kosice	Apparel
Kosice	Metal manufacturing

Note: This table lists ICs qualifying for the top 10 % in all three measures.
Source: Ketels and Sölvell (2005, 62-65).

Table 2. Regional clusters with strongest portfolio in EU-10, 2004

Region	Total number of qualifications	Average qualification per regional cluster	Share of qualified clusters in total regional cluster employment (%)
Budapest (Hungary)	23	1.53	77
Warsawa (Poland)	22	1.38	77
Katowice (Poland)	21	1.4	81
Praha city (Czech)	19	1.9	78
Lithuania	19	1.58	70
Krakow (Poland)	18	1.29	68
Liberec (Czech)	17	1.55	62
Lodz (Poland)	16	1.6	71
Wroclaw (Poland)	16	1.45	60
Poznan (Poland)	15	1.15	72
Nitra (Slovakia)	14	1.4	60
Bydgoszcz (Poland)	14	1.27	58
Slovenia	14	1.27	56
Olomouc (Czech)	14	1.4	45
Latvia	13	1.44	62
Gdansk (Poland)	13	1.44	59
Praha region (Czech)	13	1.63	43
Bratislava (Slovakia)	12	1.5	65
Brno (Czech)	12	1.2	56
Miskolc (Hungary)	12	1.09	51
Kosice (Slovakia)	12	1.71	45

Source: Ketels and Sölvell (2005, 26).

Table 3. Evaluation of Hungarian clusters, 2007

All regional clusters in Hungary 1- and 2-star regional clusters								
Region	Cluster category	Employees	Size	Spec.	Focus	Stars	Innovation	Exports
Kozep-Magyarorszag	Transportation	50163	0.81%	1.23	4.00%	**	High	Weak
Kozep-Magyarorszag	Education	44476	1.00%	1.89	3.00%	**	High	N/A
Del-Alfold	Food	34101	0.68%	2.89	7.00%	**	Low	Weak
Kozep-Magyarorszag	IT	30735	1.00%	2.26	2.00%	**	High	Strong
Kozep-Dunantul	Automotive	17091	0.66%	2.85	4.00%	**	Low	Strong
Nyugat-Dunantul	Automotive	16741	0.64%	2.98	4.00%	**	Low	Strong
Kozep-Magyarorszag	Biopharma	14197	1.00%	2.61	1.00%	**	High	Weak
Kozep-Dunantul	IT	12535	0.61%	2.64	2.00%	**	Low	Strong
Kozep-Dunantul	Building Fixtures	11702	0.50%	2.17	2.00%	**	Low	Strong
Nyugat-Dunantul	IT	10995	0.54%	2.47	2.00%	**	Low	Strong
Nyugat-Dunantul	Lighting	6888	1.00%	6.17	1.00%	**	Low	Very strong
Kozep-Magyarorszag	Lighting	6832	1.00%	2	0.56%	**	High	Very strong
Del-Dunantul	Leather	3086	1.00%	10.32	0.95%	**	Low	Weak
Kozep-Magyarorszag	Finance	43439	0.61%	0.92	3.00%	*	High	Weak
Kozep-Magyarorszag	Entertainment	28559	1.00%	1.96	2.00%	*	High	Very strong
Eszak-Alfold	Food	22460	0.45%	1.73	4.00%	*	Low	Weak
Eszak-Alfold	Construction	18230	0.28%	1.07	3.00%	*	Low	N/A
Kozep-Dunantul	Metal	17403	0.44%	1.92	4.00%	*	Low	Weak
Kozep-Magyarorszag	Publishing	16886	1.00%	1.55	1.00%	*	High	Weak
Eszak-Magyarorszag	Food	16116	0.32%	1.51	4.00%	*	Low	Weak
Kozep-Dunantul	Construction	16020	0.24%	1.06	3.00%	*	Low	N/A
Eszak-Magyarorszag	Construction	15650	0.24%	1.11	3.00%	*	Low	N/A
Kozep-Dunantul	Food	15246	0.31%	1.32	3.00%	*	Low	Weak
Nyugat-Dunantul	Food	14718	0.29%	1.36	3.00%	*	Low	Weak
Del-Dunantul	Food	14374	0.29%	1.63	4.00%	*	Low	Weak
Del-Alfold	Construction	13783	0.21%	0.89	3.00%	*	Low	N/A
Eszak-Magyarorszag	Metal	13190	0.34%	1.57	3.00%	*	Low	Weak
Nyugat-Dunantul	Construction	12918	0.20%	0.91	3.00%	*	Low	N/A
Kozep-Dunantul	Transportation	12078	0.20%	0.85	2.00%	*	Low	Weak
Nyugat-Dunantul	Hospitality	11702	0.32%	1.47	2.00%	*	Low	Strong
Del-Dunantul	Construction	11151	0.17%	0.96	3.00%	*	Low	N/A
Del-Dunantul	Finance	9012	0.13%	0.72	2.00%	*	Low	Weak
Eszak-Magyarorszag	Chemical	6130	0.64%	2.97	1.00%	*	Low	Weak
Eszak-Magyarorszag	Communications	5910	0.74%	3.47	1.00%	*	Low	Very strong
Kozep-Dunantul	Communications	5890	0.74%	3.21	1.00%	*	Low	Very strong
Nyugat-Dunantul	Heavy Machinery	5341	0.64%	2.97	1.00%	*	Low	Weak
Eszak-Alfold	Heavy Machinery	4362	0.52%	2.02	0.92%	*	Low	Weak
Del-Dunantul	Communications	4333	0.54%	3.09	1.00%	*	Low	Very strong
Del-Alfold	Constr. Materials	3863	0.64%	2.72	0.89%	*	Low	Weak
Nyugat-Dunantul	Communications	3475	0.44%	2.01	0.87%	*	Low	Very strong

(continued)

(**Table 3** concluded)

All regional clusters in Hungary 1- and 2-star regional clusters								
Region	Cluster category	Employees	Size	Spec.	Focus	Stars	Innovation	Exports
Kozep-Magyarorszag	Jewelry	3445	1.00%	1.75	0.28%	*	High	Weak
Eszak-Magyarorszag	Lighting	3357	0.65%	3.04	0.85%	*	Low	Very strong
Eszak-Alfold	Lighting	3084	0.60%	2.3	0.65%	*	Low	Very strong
Eszak-Alfold	Footwear	3066	0.70%	2.71	0.64%	*	Low	Weak
Del-Alfold	Oil and Gas	2372	0.67%	2.84	0.55%	*	Low	Weak
Del-Dunantul	Fishing	1369	0.38%	2.16	0.42%	*	Low	Weak
Eszak-Alfold	Leather	1167	0.69%	2.65	0.24%	*	Low	Weak
Nyugat-Dunantul	Leather	1041	0.61%	2.83	0.26%	*	Low	Weak

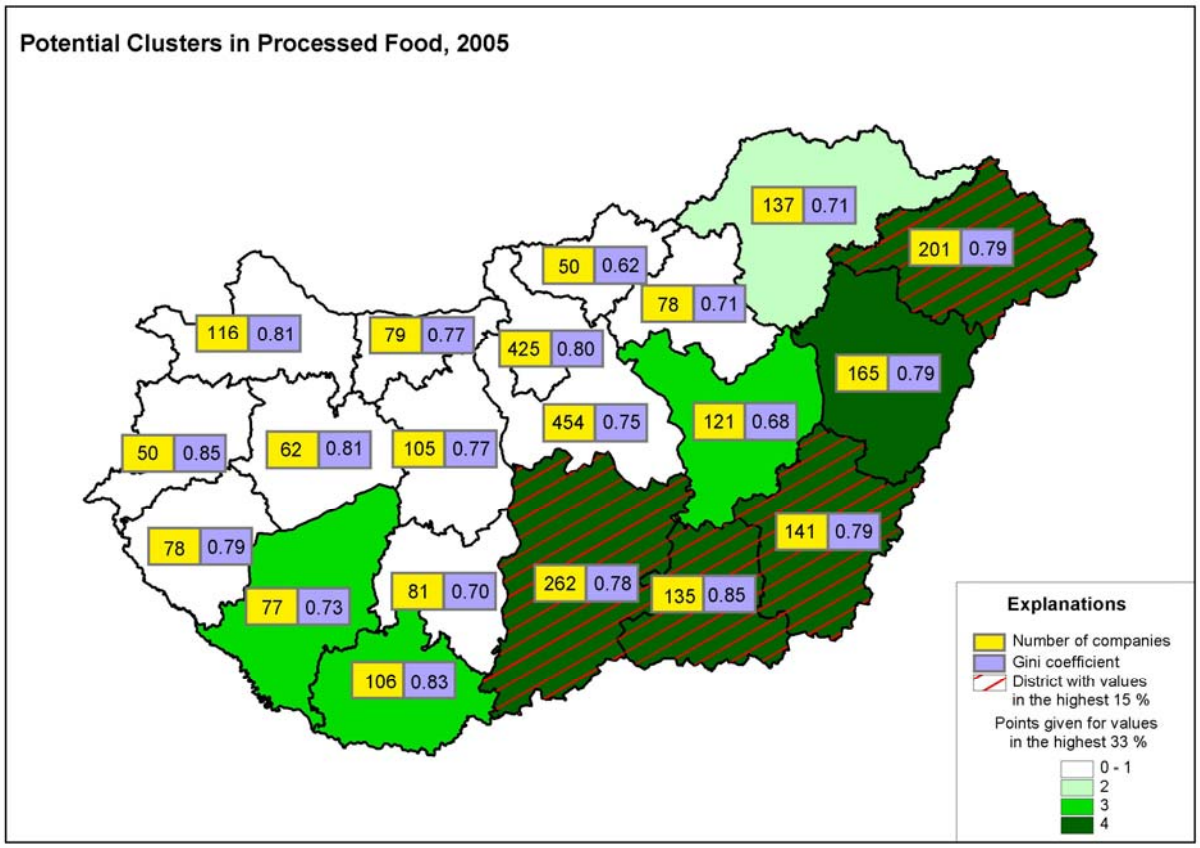
Notes: A brief description of the calculation method is provided in the text. In the case of the size, one star was given to clusters that belonged to the top 10 % of all clusters in the EU concerning this feature. The % figure in this table shows the actual share of the given Hungarian cluster in Europe's total (total employment in the given sector in all European clusters). In the case of specialization, values over 2 earned one star. For the notion of focus, those clusters which belonged to those 10 % of clusters that contributed the most to the total local cluster employment earned one star. The % figure in the table shows the actual share of the cluster in the employment of the region. Those clusters that also appeared in Ketels and Sölvell (2004)'s table are shown in bold.
Source: European Cluster Observatory special Website (http://www.clusterobservatory.eu).

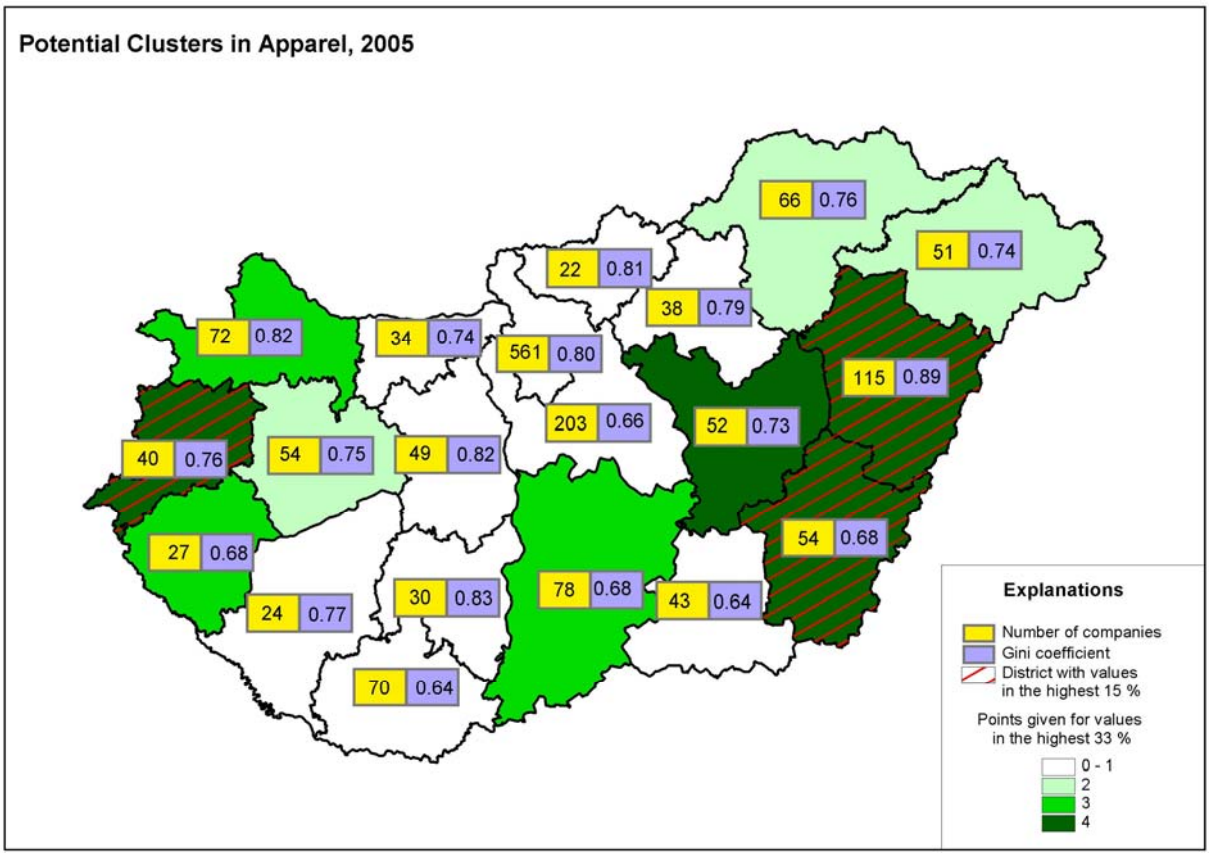
Table 4. Results of cluster mapping in Hungary using the 2005 census data

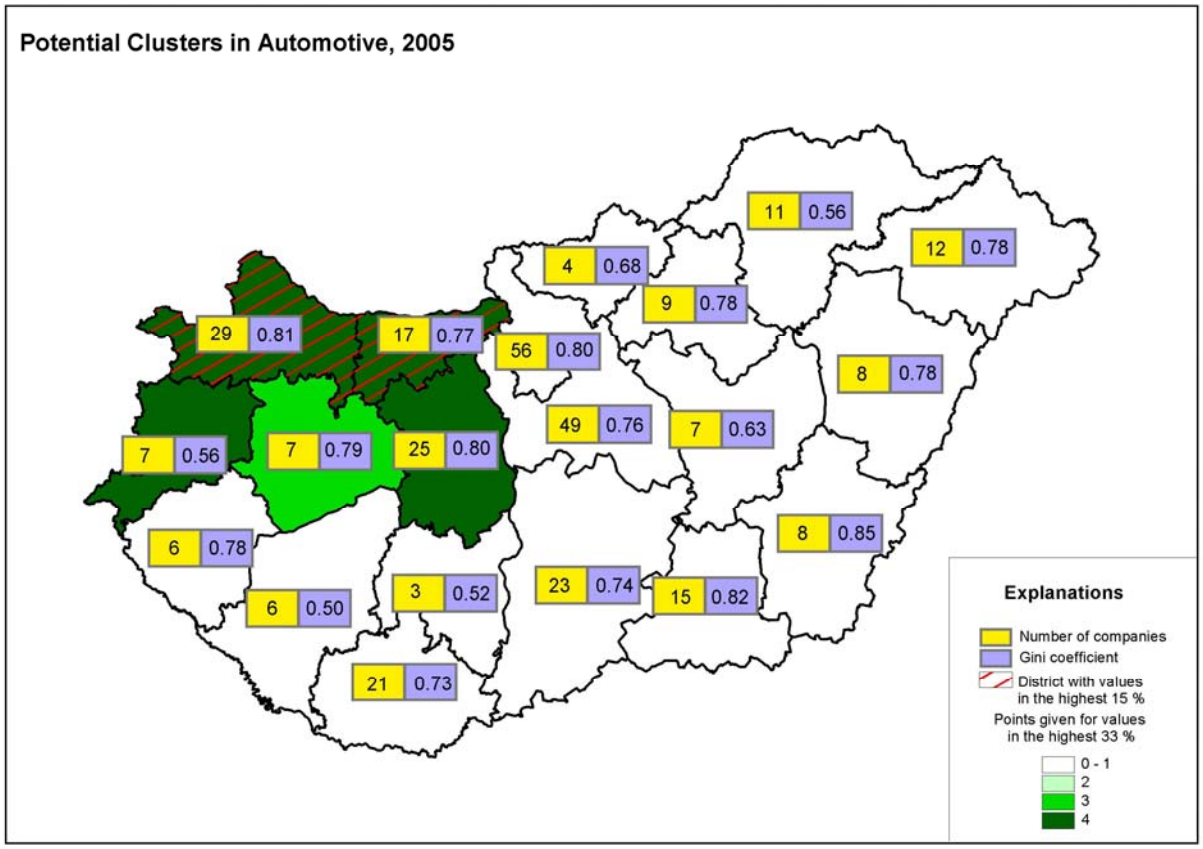
Sector	Counties	Number of firms	Gini coefficient	Qualification	Note
Automotive	Győr. Komárom	29; 17	0.81; 0.77	yes	one center
Leather Products	Vas. Baranya. Szolnok. Szabolcs	6; 17; 6; 3	0.66; 0.65; 0.58; 0.66	?	two centers, spatially disperse
Footware	Vas. Baranya. Tolna. Bács-Kiskun. Szolnok. Szabolcs	10; 15; 15; 19; 14; 27	0.64; 0.70; 0.56; 0.54; 0.73; 0.67	?	two centers, few firms
Processed Food	Bács-Kiskun. Csongrád. Békés. Szabolcs	262; 135; 141; 201	0.78; 0.85; 0.79; 0.79	yes	two centers
Building Fixtures. Equipment and Services	Veszprém. Komárom. Nógrád	238; 319; 119	0.82; 0.76; 0.68	yes	one center
Furniture	Zala. Vas. Győr. Békés	170; 124; 186; 117	0.71; 0.78; 0.81; 0.73	yes	two centers
Metal Manufacturing	Fejér. Nógrád	179; 49	0.91; 0.75	yes	two centers
Motor Driven Products	Zala. Szolnok	62; 63	0.80; 0.86	yes	two centers
Biopharmaceuticals	Hajdu	6	0.82	?	one center, few firms
Communications Equipment	Nógrád. Heves. Szolnok	18; 30; 36	0.79; 0.89; 0.89	yes	one center
Aerospace	Heves	3	0.57	?	one center, few firms
Agricultural Products	Veszprém. Baranya. Bács-Kiskun. Borsod	61; 59; 141; 93	0.81; 0.73; 0.65; 0.76	?	three centers, dispersed activities
Plastics	Bács-Kiskun. Borsod	106; 74	0.78; 0.87	yes	two centers
Analytical Instruments	Pest	87	0.77	yes	one center
Medical Devices	Hajdu	57	0.83	yes	one center
Publishing and Printing	Komárom	16	0.73	?	one center, dispersed activities
Apparel	Vas. Békés. Hajdu	40; 54; 115	0.76; 0.68; 0.89	yes	two centers
Spőorting. Recreational and Children's Goods	Baranya. Nógrád	17; 6	0.61; 0.75	?	one center, few firms
Information Technology	Veszprém. Komárom. Baranya. Pest	13; 25; 23; 127	0.77; 0.91; 0.94; 0.92	?	quickly changing spatial location
Construction Materials	Veszprém. Békés	12; 10	0.84; 0.63	no	one center, dispersed location
Chemical Products	Vas. Borsod	5; 18	0.70; 0.70	no	one center, dispersed location
Lighting and Electrical Equipment	Tolna	6	0.62	no	dispersed location, few firms

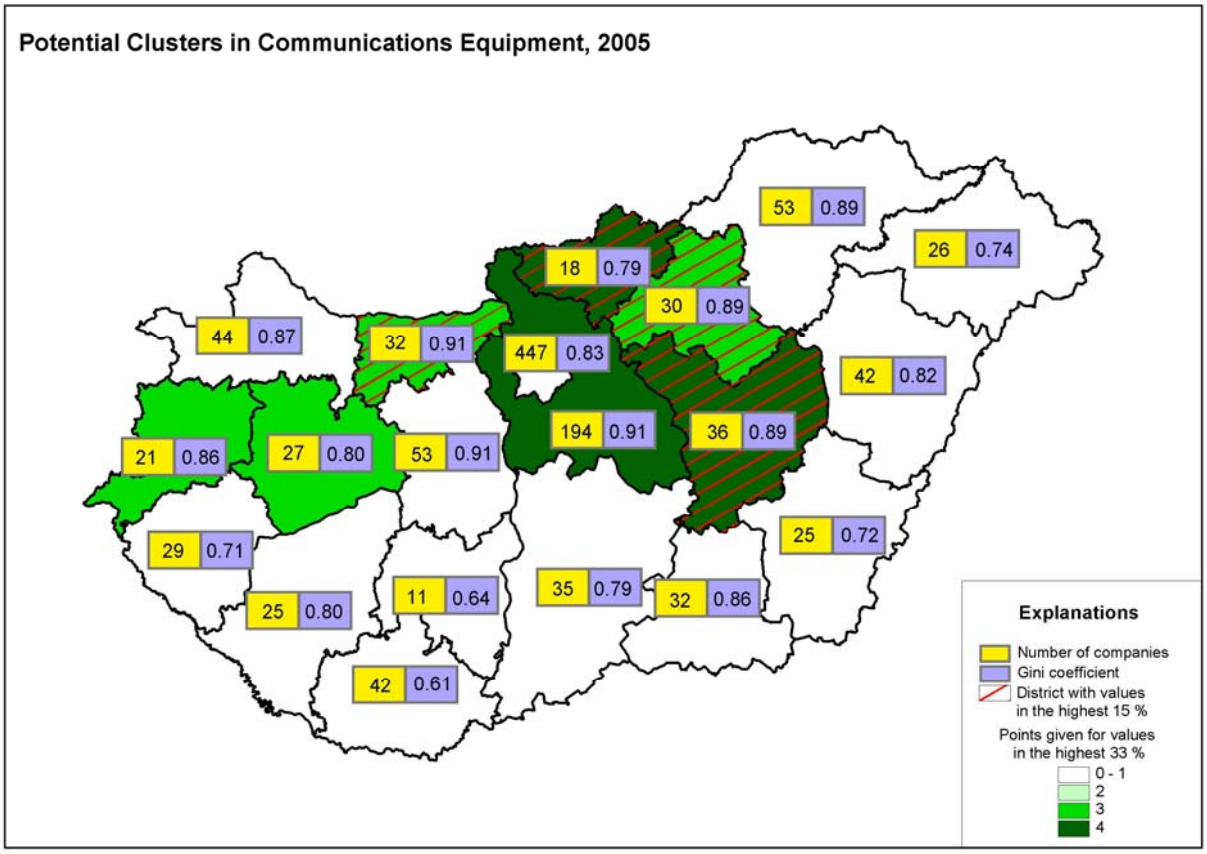
Source: Authors' estimation.

Figure 1. Potential clusters in the processed food, apparel, automotive, and communications equipment industries in Hungary, 2005





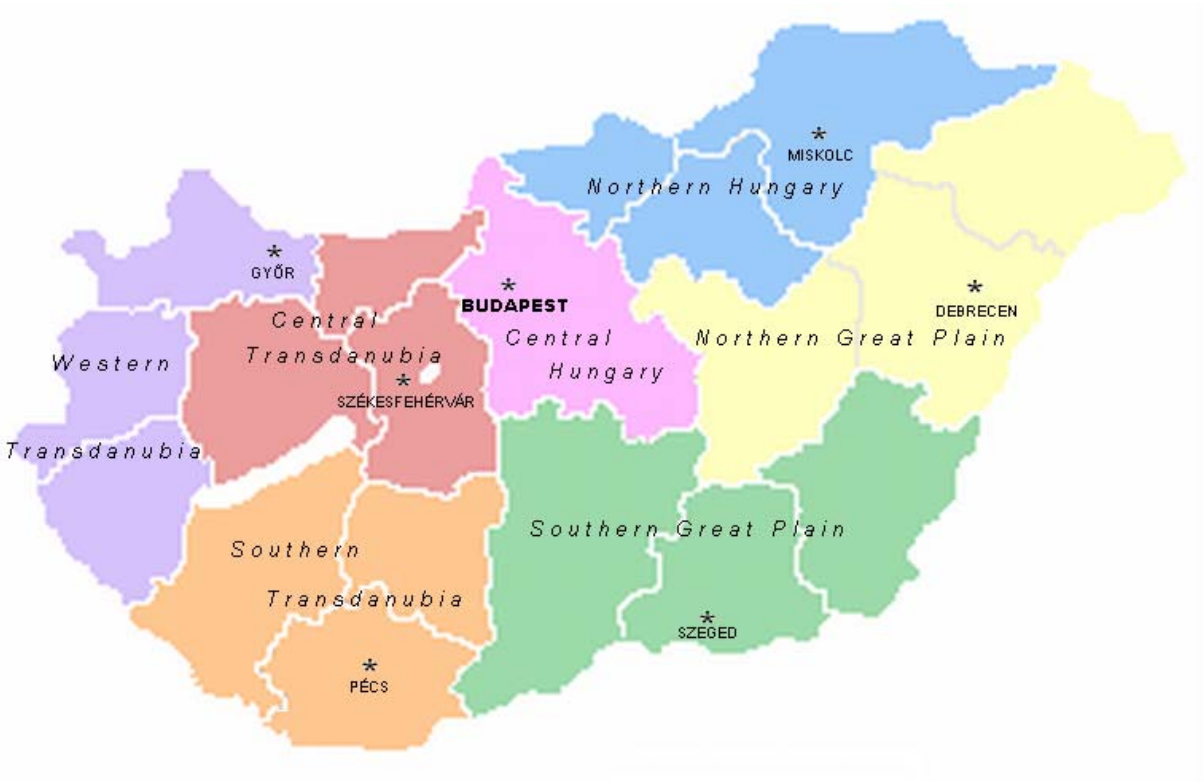




Source: Authors' illustration.

Appendix. Regional adiministration units of Hungary

(a) Comitats (NUTS-3)



(b) Regions (NUTS-2)